HYDRO-ELECTRIC INQUIRY COMMISSION

# ENGINEERING DATA

## THE QUEENSTON-CHIPPAWA POWER DEVELOPMENT

## CHAPTER "G"—CONTRACT WORK AND OTHER CONSTRUCTION PROCEDURE

WALTER J. FRANCIS, C. E.

CONSULTING ENGINEER

## Chapter 6.

## CONTRACT WORK AND OTHER METHODS OF CONSTRUCTION PROCEDURE.



Walter J. Francis.

Chapter 8.



Walter J. Francis.

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## CONTRACT WORK AND OTHER METHODS OF CONSTRUCTION PROCEDURE

Walter J. Francis.

### General

The construction of the Queenston-Chippawa Power Development was carried out under two methods of procedure, namely by contracts and by force account. Taking the elements of the plant in the order used in Chapter B, the procedure was for (a), the Intake, force account up to April, 1922, and by contract work for the completion since that time; (b), the Welland River, by force account with plant purchased or rented up to the spring of 1922, when a contract was let for dredging; (c), the Canal, by force account throughout; (d), the Forebay, by force account throughout; (e), the Screen House, by force account with a number of separate contracts for the steel work of the superstructure, the windows, the gates, and the racks; (f), the Penstocks, by force account for excavation and concrete work, with a contract for the fabrication and erection of the steel work; (g), the Power House, by force account with contracts for the Johnson valves, the turbines, the generators, the transformers, the switches, the cranes, and the miscellaneous equipment. The tail race excavation was carried on by force account. The power house railway, which is essentially a part of the permanent equipment of the plant, was also constructed by force account.

In order that I might be fully informed as to the reasons on which the decisions were based to adopt a particular method of construction procedure, I have devoted considerable time to discussing and studying the subject. I have talked the matter over with Mr. F. A. Gaby, the Chief Engineer of the Hydro-Electric Power Commission, at some length, and I have gone into the subject deeply with Mr. H. G. Acres, Mr. R. L. Hearn and Mr. Thos. H. Hogg. In the discussion, as is to be expected, much of the information given was readily confirmed. On the other hand, the nature of the subject is such that many of the statements regarding events and their sequence are known only to those engineers who were intimately identified with them as the decisions were made. Where I have been unable to establish the facts for myself, in the following remarks I have ascribed the statement to others or have stated it as an opinion after consideration.



## The Intake

### Force Account Work.

Owing to the vital necessity of protecting such a large installation as that of the Queenston-Chippawa plant from the ice menace of the Niagara River, the engineers state that in their judgment the design of the Intake, in proportion to its cost and physical dimensions, involved possibly more intensive and original engineering study than any other feature of the installation. The history of Mr. R. D. Johnson's researches and the protracted study by means of the large-scale models has already been referred to in Chapter A, HISTORICAL,

and in Chapter C, ADVISORY REPORTS. The engineers have told me that when the commencement of construction on the Queenston-Chippawa project was authorized, the study of the intake was in a nebulous state, and it was not until the spring of 1921 that their investigations were sufficiently far advanced to definitely fix the type and limits of construction. Previous to this time, certain basic requirements of the design had manifested themselves, and it was considered quite possible to commence the preliminary stages of the construction, such as the unwatering of the site and the dredging of the bed of the river; but they did not consider it possible to definitely fix the limits of the dredging or the extent to which it would be necessary to remove rock. Under these circumstances no definite specifications or detailed plans were available to form the basis of a schedule contract. Mr. Acres states definitely that the necessity of completing the work in 1921, which was kept in view from the very commencement of operations, demonstrated the wisdom of making a start on construction within such limits as the progress of the engineering studies permitted from time to time.



Accordingly, force account work was done on the Intake to the extent of completing the temporary dam for the unwatering of the site and the excavation of about 80% of the necessary earth yardage. This portion of the work progressed as part of the general programme through the worst part of the war and the post-war period, and was suspended in the fall of 1921.

During the winter and spring of 1921-22 industrial conditions suffered a period of serious depression in Canada, and, as a result, labour became plentiful and relatively cheap, and the prices of materials were greatly reduced. Furthermore, the records show that the type and design of the final

structure had been definitely developed and fixed in the meantime, so that by 1922, a complete set of detailed construction plans had been prepared.

When the resumption of work on the Intake was considered in the spring of 1922, the Hydro-Electric Power Commission felt that the time was propitious for inviting tenders for the completion of this work by contract, as had been their procedure previous to the war period, and tenders were invited publicly. The tenders received covered a wide range of prices, and appeared to indicate that pre-war conditions in the matter of heavy construction work had in a measure been restored. The Hydro-Electric Power Commission therefore entered into a contract for concluding the various classes of works on the Intake.



Contract Work.

The contract with Messrs. Tomlinson, Macaw and McDonald, of Winnipeg, was signed on May 5th, 1922, and it may be said to be the general contract for the construction of the Intake and the ship channel. It was signed on behalf of the Hydro-Electric Power Commission of Ontario by Sir Adam Beck, Chairman, and by Mr. W. W. Pope, Secretary; and on behalf of Messrs. Tomlinson, Macaw and McDonald by Mr. Robert J. McDonald for himself and as Attorney for Mr. W. S. Tomlinson and Mr. Arthur Macaw.

Under the terms of the contract, the contractor has given a surety bond from the London Guarantee and Accident Co. for $110,000, dated May 1st, 1922.

In the agreement the contractor undertakes to complete the work on or before December 31st, 1922, the contractor furnishing all plant, labour and

material with the exception of cement. The cement for the work is delivered to the contractor by the Hydro-Electric Power Commission at the nearest railway siding.

The contractor is obliged to "keep open for use in a safe condition" the boulevard of the Queen Victoria Park Commission adjacent to the site.

The general specifications, including the standard general contract conditions of the Hydro-Electric Power Commission, refer fully to such matters as insurance, inspection, interest, material, labour, responsibility, methods of procedure, plant, instructions and so forth. Provision is also made in the contract for alterations or omissions, and work in addition to that ordered and not specified in the contract is to be paid for at cost plus ten per cent.



The Chief Engineer of the Commission is the sole judge of the extension of time through unforeseen delays.

The specifications are full and complete in all particulars.

The contractor is required to pay twenty cents for each empty cement bag, which amount is refunded to the contractor upon the return of the bag to the Cement Company and its acceptance thereof.

The schedule of prices and the estimates of quantities for the contract are as follows:

COPY

| Description of Work | Quantity | Units | Price per Unit |
|---|---|---|---|
| Earth Excavation | 80,000 | cubic yards | $ 0.94 |
| Rock Excavation | 25,000 | cubic yards | 2.65 |
| Earth Fill | 81,000 | cubic yards | .20 |
| Rip-rap | 15,000 | square yards | 1.00 |
| Concrete, cement being supplied by H.E.P.C. | 32,000 | cubic yards | 5.25 |
| Placing Iron and Steel supplied by H.E.P.C. | 140,000 | pounds | .03 |
| Reinforcing Steel | 960,000 | pounds | .03½ |
| Timber in Cribs | 406 | thousand feet board measure | 70.00 |
| Iron Fastenings in Cribs | 15,000 | pounds | .04 |
| Removal of Sheet Piling and Lumber in Temporary Dam, (Timber, 464 thousand feet board measure; Iron Fastenings, 125,000 pounds; Steel Sheet Piling, 187,100 lineal feet) | Whole | Whole | $29,257.50 |



The total contract at the estimated quantities amounts to $436,727.50.

Speaking in a general way, the contract is intended to provide a clear entrance into the Welland River with a bottom width of 150 feet at Elevation 550. The present contract does not include the gathering tubes contemplated in the ultimate design. The whole of the temporary dam is to be removed and

the ship channel is to be completed for one lock gate only, the intention being to defer the construction of the rest of the lock until the necessity for its completion is proven.

## The Welland River

### Force Account.

The construction procedure on the Welland River was governed by a variety of conditions, of which the most important are stated by the engineers to be as follows;- (a), the refusal of the United States authorities to allow excavated material from the Welland River to be deposited in the channel of the Niagara River; (b), the difficult problem in the matter of the disposition of spoil in the lower two-mile reach of the Welland River, on account of the proximity of the Village of Chippawa and the main road systems on both banks of the stream; and (c), the fact that the plant used in connection with the force account work on the Intake was also suitable for use on a portion of the Welland River.



The enlargement of the Welland River involved the removal of about 2,000,000 cubic yards of earth from the bed of the stream. There were two ordinary methods of handling this material;- namely, by dipper dredge work and by suction dredge work. The dipper dredge alternative was given careful consideration and was abandoned by the engineers as a means of carrying out the whole of the work by reason of the primary fact that the only available disposal area was the Niagara River, which at that time was not permitted to be used for this purpose, and secondarily, because they believed that even

if the Niagara River were available for disposal purposes, the long haul from the upper reaches of the Welland River, taken into consideration with the necessity of handling two hand-operated swing bridges, tended to make such procedure impracticable and the cost prohibitive.

Mr. Acres states that the suction dredge alternative, insofar as the first two miles of the Welland River was concerned, was abandoned for substantially the same reason, as the Niagara River could not be used for disposal, and the discharge lines under such conditions would also have necessarily grown to a prohibitive length. Furthermore, it was impossible, within this particular reach of the River, to obtain sufficient area of suitable land for the disposal of suction dredge discharge.



On account of the difficulty of applying ordinary methods to the handling of the Welland River excavation work, it was finally decided by the engineers after a protracted period of investigation, and viewing of the operation of excavation plant on similar work in the United States, to use a high speed cable-way excavator. The advantage of this type of plant in their judgment was that it could take fuller advantage than any other type of machine of the restricted disposal areas available in the lower two-mile reach of the Welland River. The operation of the cable-way will be discussed in detail under another heading, the point having been elaborated thus far to record the fact that, in the judgment of the Commission's Engineers, a method was necessary which involved specialization, and that the problem did not lend itself to ordinary contract methods.

COPY

The work proceeded in the Welland River jointly through the agency of the dipper dredge, originally employed on the Intake work, and the cable-way excavator until the summer of 1921, when the work was suspended, first, by reason of the completion of all of the necessary dipper dredge work at the mouth of the River, and secondly by the judgment of the Commission that the operation of the cable-way excavator could be reasonably deferred for a considerable time pending a drop in labour and material costs. When the time came to resume work on the Welland River in the spring of 1922, the following conditions existed: the excavation of the lower two-mile reach of the Welland River had been practically completed, and the topography of the shores from that point to Montrose had become much more favourable for disposal purposes; and the conditions surrounding the letting of construction contracts had also become more favourable, as already mentioned in the case of the Intake. I am informed that the Commission therefore considered it advisable to follow the same procedure as in the case of the Intake for the remainder of the dredging work in the Welland River, and to invite tenders for the completion of the same. Accordingly, specifications and plans were issued giving the parties tendering the option of submitting (a) a price covering excavation only and (b) a price covering the excavation and final disposal of excavated material.



The consideration of the tenders received resulted in the decision to let a contract for the dredging to Messrs. E. O. Leahy & Co. Limited, Ottawa, Ontario.

Contract Work.

The contract with Messrs. E. G. Leahy & Co. Limited, was dated May 22nd, 1922, and is a three-page typewritten instrument executed under the signature of the Chairman and the Secretary of the Hydro-Electric Power Commission, and the President and the Secretary-Treasurer of E. G. Leahy & Co. Limited. It includes four mimeographed pages of instructions to bidders, together with thirteen printed pages of general conditions, twelve mimeographed pages of specifications for proposition No.1, eleven mimeographed pages of specifications for proposition No.2, four mimeographed pages in the form of a tender and one blue-print showing a plan, profile and section of the work.



The Contractor has deposited One Hundred Thousand Dollars ($100,000.00) of Victory Bonds with the Hydro-Electric Power Commission as a guarantee of the fulfilment of the contract.

In the agreement, the Contractor undertakes to remove not less than 800,000 cubic yards of material by the 31st day of December, 1922. The work required to be done is all under proposition No.2.

The Contractor agrees that the contract prices are to include the furnishing of all labour and materials, (excepting that specified to be supplied by the Commission), and the providing of all plant and apparatus required. The contract requires the Contractor to properly drain the disposal areas, and it places upon him the responsibility of protection to property and the liability for action for damages. It also puts him under obligation to remove slips or subsidence outside the stipulated disposal

areas without charge.

The contract is divided into four sections containing quantities estimated for tender purposes as follows:-

Section I, Canal, Station 15 to Station 60 ..... 325,000 cu.yds.

Section II, River section, Station 165 to Station 244+40 . 500,000 cu.yds.

Section III, Canal, Station 0+00 to Station 15+00 ..... 175,000 cu.yds.

Section IV, Welland River, Station 244+00 to the entrance to the false or temporary channel and false channel to Station 15, canal chainage ..... not estimated.

The prices in the contract are:



Earth excavation ..... 35¢ per cu.yd.

Earth excavation, in case contract be cancelled when excavation has exceeded 500,000 cu.yds. but has not reached 800,000 ..... 35¢ per cu.yd.

Earth excavation in quantities less than 500,000 cu.yds. . 40¢ per cu.yd.

## The Canal and Forebay

### Force Account.

By reason of the magnitude of the quantities involved and the tedious and protracted engineering studies incidental to the fixing of its location and characteristics, the engineers of the Hydro-Electric Power Commission considered that the Canal constituted the controlling factor having to do with

the success or failure of the project as a whole.

Actual study of this particular phase of the problem commenced in 1914, and sufficient information was accumulated during the succeeding year to justify, in the opinion of the engineers, a request to the Government of the Province of Ontario for authorization to proceed with the design and construction of a plant for the utilization of the surplus treaty water computed at 6,500 cubic feet per second. This recommendation not having been entertained by the Government, no continuous intensive study was made of the project until, as is stated by the engineers, war demands for electric energy had reached a stage which forced both the Federal and the Provincial Government to give serious consideration to any feasible project for increasing the existing supply of electric energy. This attitude on the part of the Ontario Government finally resulted in authorization being granted to the Hydro-Electric Power Commission to proceed with the construction of the Queenston-Chippawa project, and the Second Act of the Ontario Legislature, entitled "The Ontario-Niagara Development Act, 1917," (7 George V, Chap. 21) was assented to on April 12th, 1917. Previous to this latter date, extensive topographical, contour and drilling surveys had been made. These established among other things a condition which had much to do with the matter under present discussion, namely, that the earth overburden along a considerable length of the route of the proposed power canal was heavily impregnated not only with ground water but with water which was under such pressure that in numerous core-drill holes it actually rose to a level approximately 20 feet above the elevation

of Lake Erie. This condition immediately forced the conclusion that the removal of the earth overburden would be attended by immense difficulty, in the judgment of the engineers of the Commission, if handled by small steam shovels or by drag-line excavators. The engineers began an investigation of this phase of the problem, similar to that above mentioned in connection with the removal of the sub-aqueous earth in the Welland River, with the result that a decision was reached to use a type of plant not hitherto used on work of this character, namely, the largest shovels developed up to that time. The basic idea of this departure in the minds of the engineers of the Commission is stated to be that these shovels would have sufficient reach to operate continuously from the rock stratum underlying the saturated overburden, thereby obviating the factor which would have destroyed the effectiveness of the ordinary railway type shovels, namely, the burying of the same, along with their service tracks, in the soft bottom.



The decision to utilize large shovels was made in the latter part of the year 1916, and in January 1917 authority was given to the engineers by the Hydro-Electric Power Commission to make the necessary purchases.

When the orders had been placed for the large shovels, the demands for munitions and other war materials were showing signs of becoming so acute as to largely absorb the supply of labour and material, with the inevitable consequent increase in costs. It should be noted that in this same year, 1917, the Department of Railways and Canals of Canada ordered a complete cessation of work on the Welland ship canal, and there was a

widespread impression that it was physically and financially impossible to carry on schedule contracts under the conditions then obtaining.

During the investigatory period the engineers of the Hydro-Electric Power Commission also decided to use electric power for operating the construction plant, giving as their principal reason that its cheapness, and its availability in any quantity required, offered very definite indications for economy as compared with American coal, the cost of which was even then showing indications of increasing and the supply of which was becoming uncertain.

The records show that the war demand for electric power developed at a constantly accelerating rate from the year 1915, and when the extreme need for additional electric power manifested itself in 1917, the engineering investigations in connection with the Queenston-Chippawa power development were just emerging from the preliminary stage. Consequently, to meet the demand for power the engineers of the Hydro-Electric Power Commission say that they considered it necessary to commence actual construction operations on the basis of a few fixed and definite elements of design, although these elements had not been developed in sufficient detail to permit the preparation of final detail designs and definite estimates of quantities. This statement applies more particularly to the Power House and the Intake, but also in some degree to the portion of the work now under discussion, namely, the Canal.



At the time when it became necessary to actually commence construction work, therefore, the engineers of the Hydro-Electric Power Commission say

that there were four outstanding conditions influencing the Commission as regards the general policy of construction procedure. These points were:- (a), the saturated condition of the earth overburden as evidenced by core-drill surveys, and the consequent necessity of utilizing a special type of plant for removing the earth overburden; (b), the growing disorganization of the labour market and raw material market; (c), the economy of utilizing electric power for the operation of the construction plant as indicated by the conditions surrounding the supply of American coal; and (d), the necessity, due to the urgency of war conditions, of commencing construction work while many of the plans for the project as a whole were still in the investigatory stage.



The engineers of the Hydro-Electric Power Commission state that to the existence of the above conditions was largely due the decision to proceed with the work on the Canal on a force account basis, but in order to test the wisdom of this decision, and in the possible hope of obtaining tenders even approximately comparable with pre-war prices, it was decided to submit such data as were then available to a selected group of recognized general contractors known to have been previously identified with work of the character proposed. The firms selected were supplied with the general specifications and a plan and profile of the proposed canal, as well as a record of the test borings, all in sufficient detail to enable the tenderers to submit firm prices in event of their desiring to undertake the proposed construction.

I have seen the data referred to, together with the correspondence

which passed in the above connection. For convenience of reference I have had the information regarding the borings re-drawn and included herewith as pages G-17 to G-19 inclusive. It does not seem necessary to include the copies of the general plan, because the location given was the same as that finally used and as already submitted in Chapter "E", the general description of the work. Neither does it seem necessary to refer at length to the specifications, which were quite complete for the purpose in hand and gave all the essentials information to the prospective tenderers.

The firms with whom there was formal correspondence were:- The Foundation Company, Limited; Larkin & Sangster; Baldry, Yerburgh & Hutchinson, Limited; The Dominion Construction Company, Limited; The Dominion Dredging Co., Limited; and Wm. Cowlin & Son (Canada), Limited.



The inquiry letters were written during December 1916, and were in the following general form, each individually addressed to the prospective tenderer from Mr. Gaby's office, on the letterhead of the Commission.

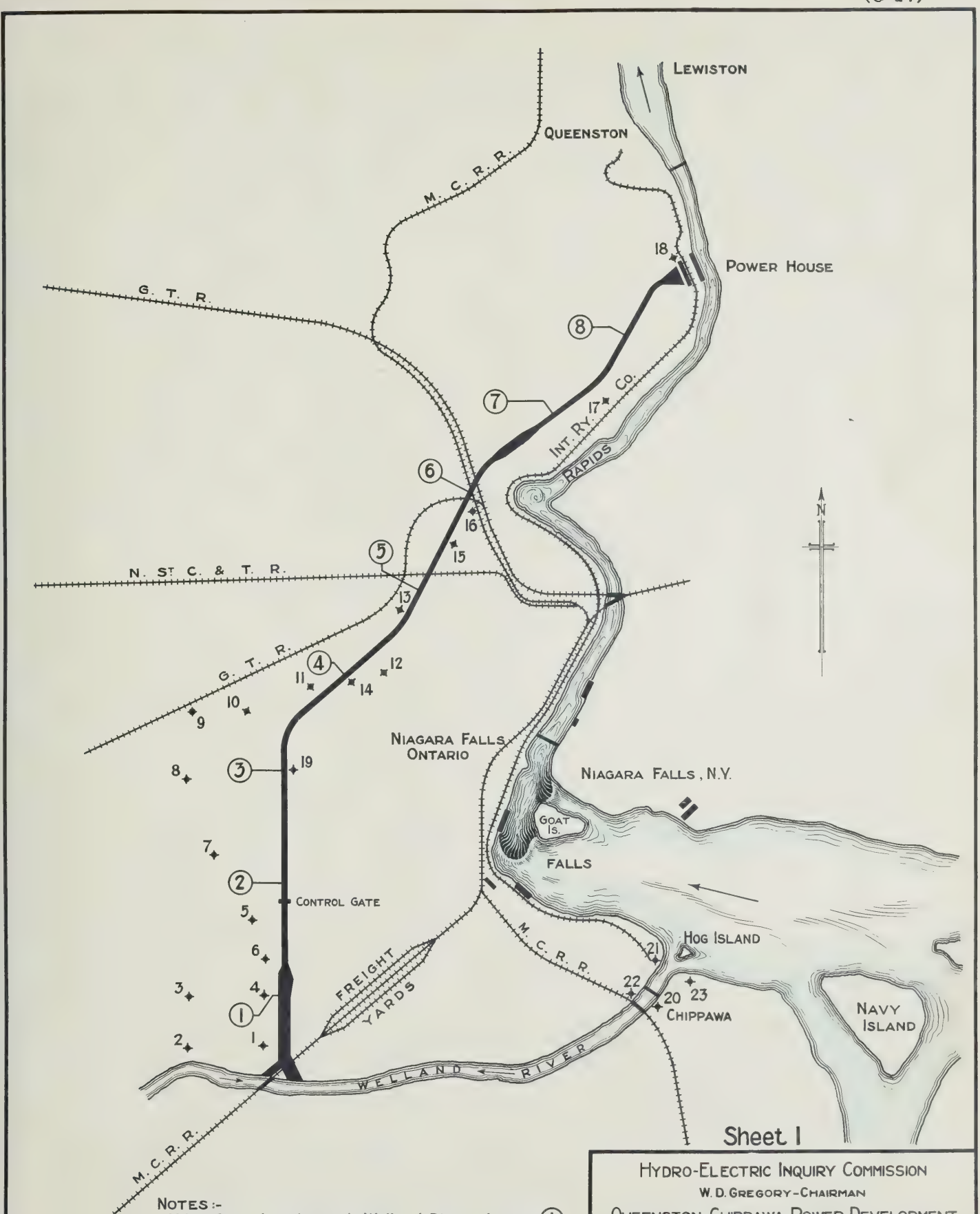
"Gentlemen:- re Niagara Development.

We are mailing you under separate cover plans and specifications covering earth and rock work in the power canal which will form part of the above development. We would like you to submit a tender price per yard for the excavation of earth and rock in connection with this work, the said figures to be in our hands not later than Jan. 5th, 1917. We will be glad to give you further information as to estimated quantities, or any other information available which may be of use to you.

Yours truly,

Hydro-Electric Power Commission of Ontario.

Chief Engineer
per ....."

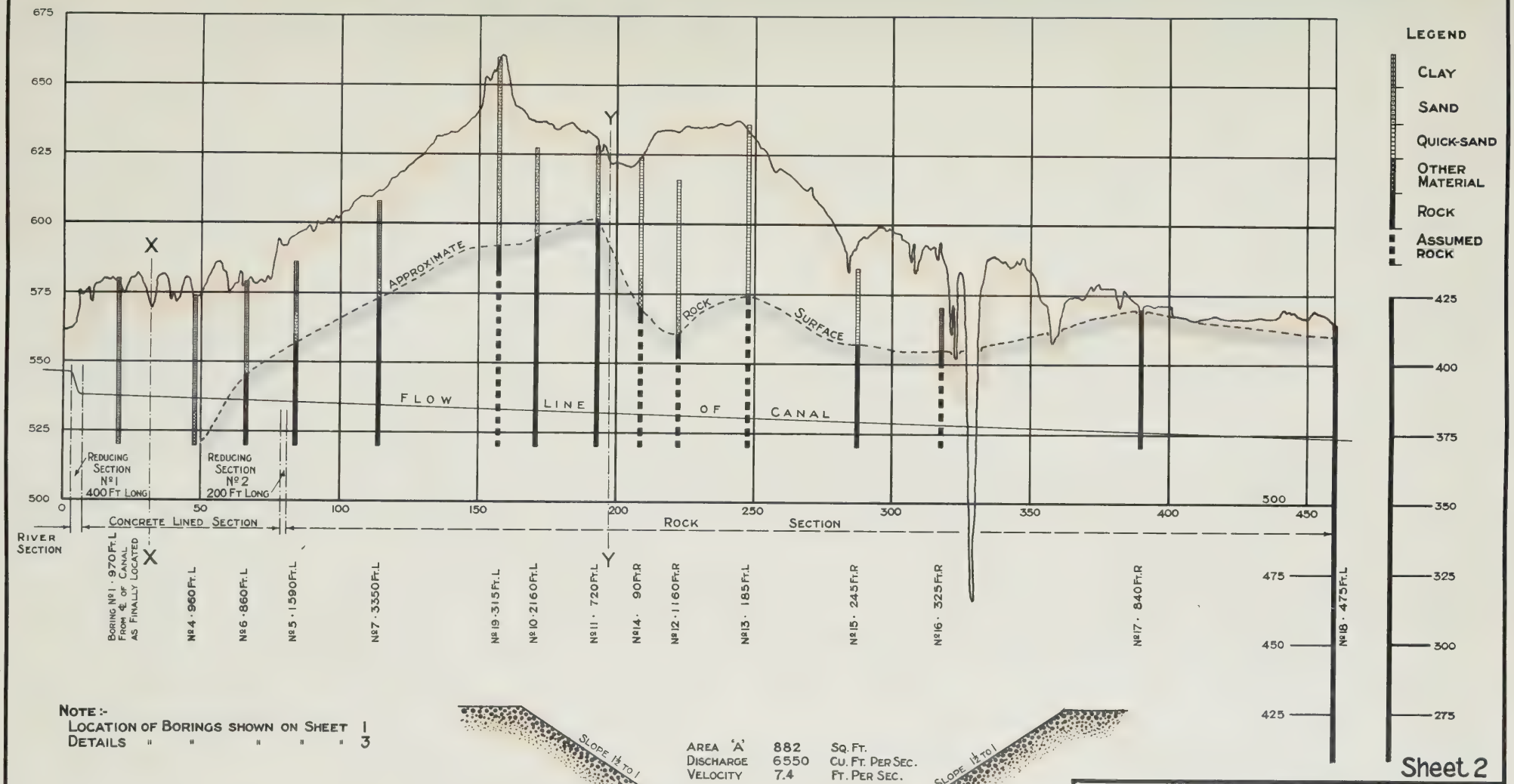



Sheet 1

NOTES:-
Miles from junction with Welland River shown:- (1)
Location of Borings shown :- ✦

Scale of Miles
0 ½ 1 2

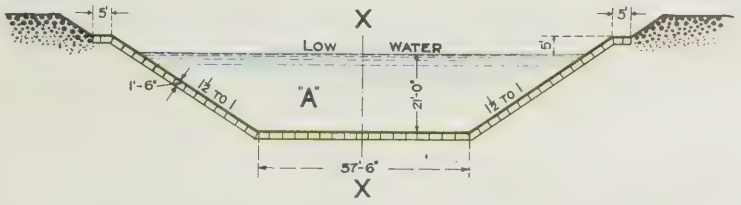
HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY-CHAIRMAN
QUEENSTON-CHIPPAWA POWER DEVELOPMENT
# LOCATION OF BORINGS
MADE UP TO MARCH 4th, 1916
## IN RELATION TO FINAL CANAL LOCATION
Toronto, Nov., 24th., 1922, Made by G.E.B., Checked by L.A.H.
WALTER J. FRANCIS, C.E.,
CONSULTING ENGINEER



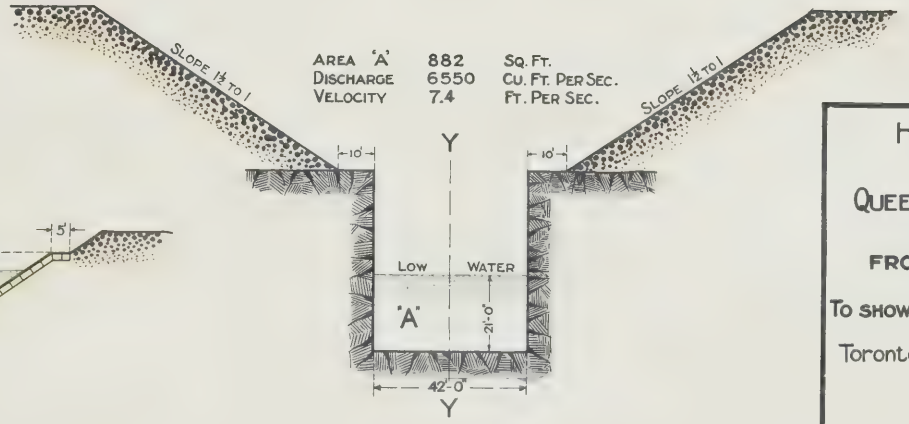

Sheet 2

NOTE :-
LOCATION OF BORINGS SHOWN ON SHEET 1
DETAILS " " " " " 3

AREA 'A' 1871.4 SQ. FT.
DISCHARGE 6550. CU. FT. PER SEC.
VELOCITY 3.5 FT. PER SEC.




AREA 'A' 882 SQ. FT.
DISCHARGE 6550 CU. FT. PER SEC.
VELOCITY 7.4 FT. PER SEC.




HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY - CHAIRMAN

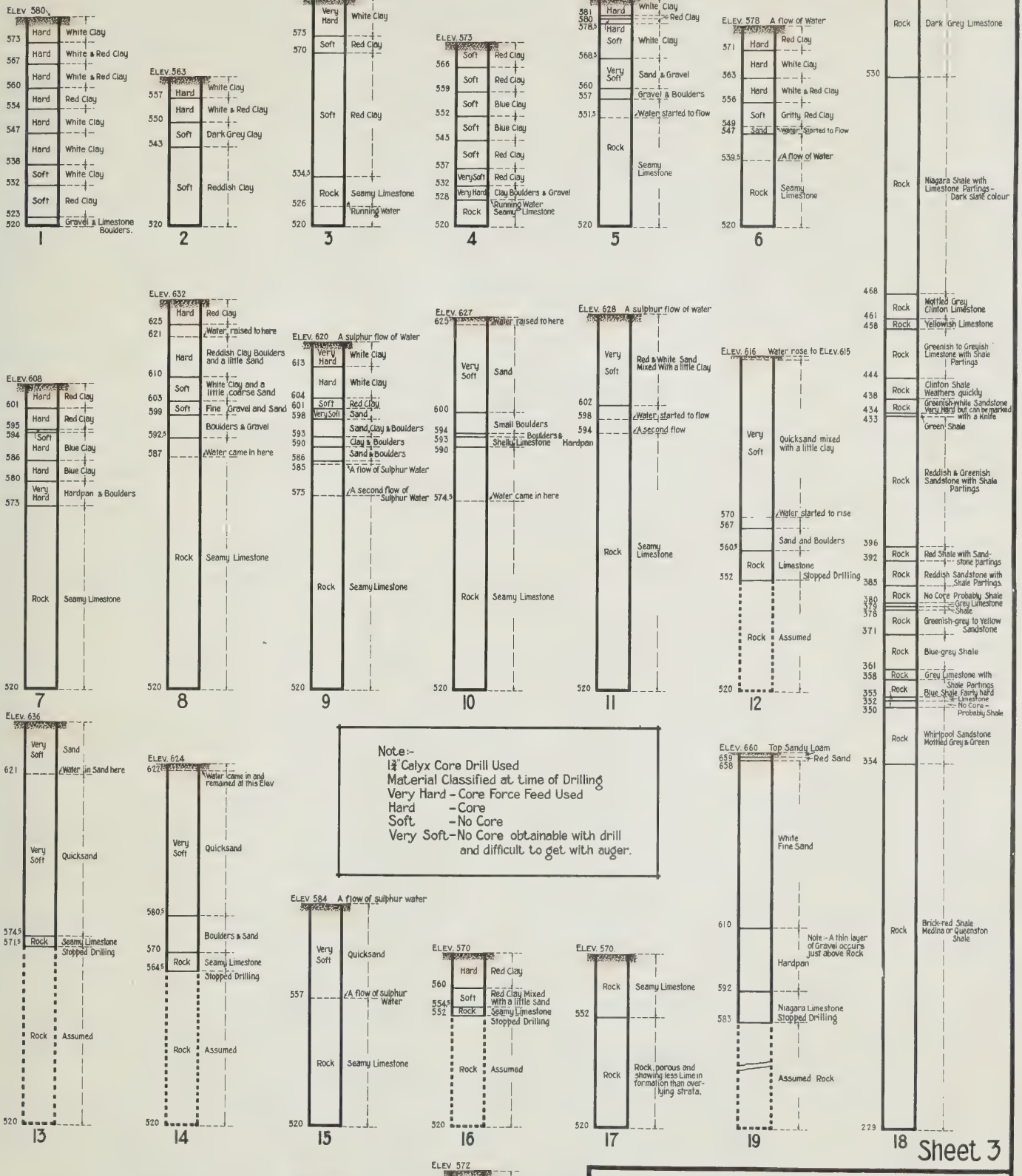
QUEENSTON-CHIPPAWA POWER DEVELOPMENT

# PROFILE OF CANAL

FROM MONTROSE TO SMEATON'S COVE
AS PREPARED MARCH 4th, 1916
TO SHOW BORINGS AND OTHER INFORMATION AVAILABLE FOR PROSPECTIVE TENDERERS
Toronto, Nov. 24th., 1922, Made by [illegible] Checked by [illegible]

WALTER J. FRANCIS, C.E.,
CONSULTING ENGINEER

(G-18)




HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY - CHAIRMAN

QUEENSTON-CHIPPAWA POWER DEVELOPMENT

# DETAILS OF CORE BORINGS

AS AVAILABLE AT

## MARCH 4TH 1916

Toronto, Nov. 24th., 1922, Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS, C.E.,

CONSULTING ENGINEER

FOR LOCATION OF BORINGS SEE SHEET I

The replies to these inquiries are given below verbatim.

Under date of December 29th, 1916, The Foundation Company, Limited, replied in two separate letters as follows:-

(Copy)

"The Foundation Company Limited
Bank of Ottawa Building
Montreal

December 29th, 1916.

The Hydro-Electric Power Commission of Canada,
University Avenue,
Toronto, Ontario.

COPY

Gentlemen:- Attention Mr. H. G. Acres.

With reference to our conversation yesterday, I enclose herewith letter to the Commission, along the lines which we discussed.

I should be very glad if you would bring this matter to the attention of whoever in your Organization is in a position to speak on a question of policy of this kind. I know that you personally appreciate the difficulty in submitting a common sense lump sum, or unit price, bid at this time, and I trust that the other members of your Organization realize that our failure to submit such a bid is simply due to the fact that we would be offering to do something which we would have no assurance we could carry out.

I trust that your Commission will give serious consideration to the form of contract which I have proposed. I honestly feel that with a skilled organization a contractor can save an owner much more than the amount of his fee. This is demonstrated by the fact that very few large corporations do their own construction work, for example, I might mention both the Pennsylvania and Grand Central Terminals, New York, the Pennsylvania Tunnel, New York, the Rogers Pass Tunnel, on the C.P.R., the Ogden shops, C.P.R., the Winnipeg Terminals, C.P.R., the International Nickel Company's refinery (the largest ever constructed) the Cedars Rapids Power Development, the Laurentide Developments at Grand Mere, and numerous other large pieces of construction work, which have been done on this basis. These corporations are run by hard-headed business men, who do not waste any money. They have large organizations, yet they seldom undertake construction work with their own forces. They

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

are operating companies, and it is a fact that an operating company cannot do construction work as cheaply as a construction company. You will note that financial interests who are engaged in both construction and operation almost invariably run the construction end of their business as a separate and distinct corporation, notwithstanding the fact that they have in their operating companies, and in their engineering companies, some of the cleverest men in the business, whose efficiency, ability and experience, classes them among the big executives.

Thanking you for your courtesy in this matter, I am

Yours very truly,

(signed) R. H. Chadwick

Eastern Manager."

(copy)



"The Foundation Company Limited
Bank of Ottawa Building
Montreal

December 29th, 1916.

The Hydro-Electric Power Commission of Ontario.
University Avenue,
Toronto, Ontario.

Gentlemen:-

With reference to your invitation for tenders for the excavation for the Montrose-Smeatons Curve Power Canal, we may state that after going over this project and giving it our most careful consideration, we have come to the conclusion that a lump sum, or unit price tender, which, we understand, is what you desire, is, at this time, from the standpoint of the contractor, impracticable.

On account of war conditions, prices of materials fluctuate between wide limits almost from day to day. Certain articles necessary for this work, as, for instance, explosives, tool steel and steel rails may be commandeered by the Government, and their use, except for military purposes, may be prohibited. It seems certain that some form of national service, or modified conscription, will be introduced, thus taking the control of labour out of the hands of

the employer. Under the circumstances we cannot conscientiously quote a fixed price on work of this kind extending over a period of several years, unless the price is sufficiently high to cover the contingent risk of the present abnormal conditions. Granted, even a generous figure, a continued advance in prices might involve a contractor in an enormous loss, while, on the other hand, an early termination of the war, accompanied by a break in the labour and material market, would give a contractor a profit which would be manifestly unfair to the Commission.

Under the circumstances we respectfully suggest, that the work might with advantage be carried out under a form of contract whereby the Commission would pay the actual cost, together with a retainer in the form of a lump sum fee, for the services of the contractor. It has been argued that in a case of this kind an owner might better do the work itself, and thus save contractor's fee. We take exception to this argument, and claim that a contractor doing a large business has advantages not possessed by any organization, however efficient, which is not continuously engaged on a large scale in the construction business. The contractor has available a large corps of experienced men, ranging from executives, managers and superintendents, down to foremen and skilled workmen, all of whom have made construction work their specialty. These men are employees of long standing, and possess a loyalty to their organization not possible in a force organized for a single piece of work. Their personalities and capabilities are well known to their employers and to each other, and from the commencement of the work the organization operates as a trained unit.



The value of such an organization is demonstrated by the fact that it is customary for contracting companies to hold their leading men on pay through dull times, often sacrificing a large sum of money rather than lose their organization. This policy is not prompted by sentiment, but by ordinary business judgment, as it is known that when good men are let go they immediately get employment elsewhere, and are not available at a moment's notice. The men that are available are those, who in the judgment of their former employers, were not worth holding. The use of this organization is what an owner gets for the fee paid a contractor.

We might suggest, that on a contract of this kind the fee be based on a sliding scale, whereby the contractor's compensation would be decreased if the unit costs of the work exceeded the estimate, and, on the other hand, increased if the work was done at a cost less than the estimate. The estimated figures could be prepared by your engineers and ours working in conjunction and agreeing on each item. A contract of this kind would be absolutely fair, as the interests of the owner and contractor are identical. As an additional protection to the Commission, we might suggest a clause whereby, if at any time

the work was not carried out efficiently and economically the owner would have the option of cancelling the contract and carrying on the work with its own forces.

We would appreciate an expression of opinion from the Commission, as to whether or not a proposal along these lines would receive a favorable consideration. We, on our part, feel confident that we could submit a proposition of this kind that would be more attractive than any unit price bid which could be submitted by a reputable contractor under present day conditions. If the Commission is disposed to consider a contract of this kind we would immediately assign our best men to this work to prepare careful estimates of cost, and to submit definite figures at the earliest possible moment. We suggest that a contract of the form here proposed might be drawn to include, at your option, the construction railway transmission lines, concrete work, and installation of machinery, in addition to the excavation work now under consideration. We have, in our organization at the present time, men of wide experience in all these lines, who have been associated with some of the largest hydro-electric developments on this continent, and I think we can demonstrate to your satisfaction our ability to handle the whole, or any part, of this work expeditiously, and economically. At this time we are particularly well equipped to take on this work, as our Company is constructing the new refinery for the International Nickel Company, at Port Colborne, only a few miles from your work. In connection with the Nickel contract we have organized employment bureaus in Toronto, Hamilton, Ottawa, Montreal and Winnipeg, the services of which will be available on your work. From the standpoint of materials, I may say, we have purchasing agents in Port Colborne, Montreal, Pittsburg, New York and Chicago giving us facilities that, as far as we know, are not possessed by any other contracting company.



Yours very truly,

THE FOUNDATION COMPANY LIMITED

(signed) R. E. Chadwick

Eastern Manager."

The reply of Messrs. Larkin & Sangster is dated December 30th, 1916, and is as follows:-

(Copy)

Larkin & Sangster
Buffalo

December 30th, 1916.

Frederick A. Gaby, Esq.,
Chief Engineer, Hydro-Electric Commission,
TORONTO, Ont.

Dear Sir:- Niagara Power Development

We are in receipt of your favor of the 27th inst. inviting us to tender on the earth and rock work in connection with the proposed Niagara development.

We may say that we understood that the Commission intended to undertake this work itself, and as this was so obviously the proper course to take under existing circumstances, your enquiry was somewhat unexpected.



We can safely assume that your decision to proceed with the work at this time is forced upon you by the increasingly serious shortage in the Niagara power supply. You must therefore aim at a maximum of economy and speed in construction. As regards economy, your decision to use electric power is well advised, in view of the price at which you will be able to obtain it, and a very great saving in construction cost should result.

To ensure speed, it will be absolutely necessary to use new electrically driven plant of the newest, heaviest, and most up to date type that money can buy.

We do not know of any contracting firm on this continent which can meet the above requirements, or which could meet them, by the purchase of new plant of the requisite type inside of one year or eighteen months.

Apart from the time which we would require to install a plant under the foregoing conditions, the capital charges, together with a margin of profit commensurate with the risks involved, would result in a tender price probably far in excess of any estimates your engineers have made on a strictly cost basis, and with the added advantage of the Provincial interest rate.

Under the circumstances, therefore, we do not consider that any

good purpose would be served by submitting a tender on the work.

We have taken the liberty of expressing our opinion at some length, first because we have watched the development of this project through its preliminary stages with great interest and have given it considerable thought, and second, because we have a desire to have clearly understood our reasons for not submitting a tender, as we do not wish to prejudice our standing with the Commission in connection with future work which may be carried out under normal conditions, and which we may be better able to handle.

Very truly yours,

Larkin & Sangster.

(signed) H. M. Larkin"

To the inquiry, Messrs. Baldry, Yerburgh & Hutchinson, Limited, replied under date of January 6th, 1917, as follows:-



(Copy)

"Baldry, Yerburgh & Hutchinson Limited

14 Queen Street,
St. Catharines, Ont.
Jan. 6, 1917.

Sir Adam Beck,
Chairman,
Hydro-Electric Power Commission of Ontario,
University Avenue,
Toronto, Ont.

Dear Sir:-

With regard to the interview you kindly granted me on the 11th ult. we have since had an opportunity to view the plans and specifications of the proposed Niagara Development scheme. We have also visited the site and acquainted ourselves with conditions.

The plant we have employed on the construction of the Welland Ship Canal for the Dominion Government is in every way suitable for the work you have under consideration and by associating ourselves with the Dominion Dredging Co., our own plant could be augmented to

whatever extent may be necessary in order to carry out your work in the required time.

We have a first class organization and life long experience in the execution of large excavating undertakings which can be placed at your disposal, but under existing conditions of labour and material we could not quote you a fixed contract price such as would prove satisfactory to either party but we should be satisfied to undertake the work for you on a reasonable margin of profit for the services rendered which profit we would be content to limit. By an arrangement such as this you would insure yourself against any malingering or inflated expenditure for it would be as much in our interest as yours to keep the cost within the limits of our estimate.

Subject to no rise or fall in the present day price of labour and material, or other unforseen conditions arising during the progress of the Contract, we are of the opinion the nett cost of the excavation exclusive of plant, should not exceed $4,250,000.00 (Four Million, Two Hundred and Fifty Thousand Dollars) based on the following quantities:-



8,500,000 (Eight Million, Five Hundred Thousand Cubic (Yards) of Earth excavation including disposal.

2,500,000 C.Yards (Two Million, Five Hundred Thousand Cubic Yards) of Rock Excavation, including disposal.

The above estimate does not include the cost of Construction Railroad.

We offer to execute and complete in a satisfactory manner the whole of the necessary excavation at 7% (Seven per cent) on nett cost, the amount of our remmeration not to exceed $317,000.00 (Three Hundred and Seventeen Thousand Dollars) provided only the above mentioned quantities are not increased. In other words, if the final quantities prove to be 11,000,000 (Eleven Million) cubic yards and the nett cost $4,500,000.00 (Four Million Five Hundred Thousand Dollars) we only receive 7% (Seven per cent) on the amount of our estimate, i.e. $4,250,000.00 (Four Million, Two Hundred and Fifty Thousand Dollars).

On the other hand if both the quantity of excavation executed and the nett cost is less than estimated we only receive 7% (Seven per cent) on nett cost.

Other work than excavation such as Concrete, Construction Railway, Trestling, Buildings, etc. we would carry out at 7% (Seven per cent) on net cost. All the necessary tools, machinery and plant to be provided by us on the following rental basis:-

| | | | |
|---|---|---|---|
| Steam Shovels | $425.00 | per month | |
| Drag Line Machines | 470.00 | " " | |
| Large Locomotives | 250.00 | " " | |
| Saddle Tank Locomotives | 200.00 | " " | |
| 25 ton Locomotive Crane | 375.00 | " " | |
| 15 ton Locomotive Crane | 200.00 | " " | |
| 16 C.Yd. Cap.Air Dump Cars | 65.00 | " " | |
| 12 C.Yd. Cap.Oliver or Western Air Dump Cars | 40.00 | " " | |
| Flat Cars | 25.00 | " " | |
| Steel Rails per ton | 1.10 | " " | |
| Boilers, Machinery etc. | 2-4/5% | " " | on first cost. |

All perishable material such as fish-plates, spikes, bolts, ties, temporary buildings, etc. to be a charge against and included in net cost.

Until such time as you are in a position to say if the basis of this proposal is acceptable to your Commission, we would ask you to kindly respect our wishes and treat the matter in the strictest confidence, for we do not wish to approach the Dominion Government in regard to release of our plant unless we are reasonably assured we have found a field for its employment.



Yours truly,

BAILEY, YEABURGH & HUTCHINSON, Limited.

(signed) W. H. Hutchinson"

The reply of The Dominion Construction Company, Limited, is dated January 2nd, 1917, as follows:-

(Copy)

"The Dominion Construction Company, Limited
Railroad Contractors

Toronto, Ont.
Please refer to file No. 113412 Jany. 2, 1917.

Mr. Acres,
Hydraulic Engineer,
Hydro-Electric Power Commission,
TORONTO, Ont.

Dear Sir:-

We beg to advise you that we have gone over your plans and specifications in connection with your Power Development at Niagara Falls, Ont. and are pleased to submit the following:-

We propose to construct the Canal and other work that you contemplate on a cost basis, plus 8%, plus rental of equipment; the cost of the work to be based on earth at 38¢ per cu.yd. rock at $1.20 per cu.yd. and concrete at $7.00 per cu.yd. Any saving effected between these prices and the actual cost will be divided equally between the Commission and ourselves.

We agree to place sufficient plant on this work, according to the judgment of the Engineer, and to complete it in time as required by the Commission.

Owing to the abnormal conditions at the present time, we are not in a position to give you a bid on flat prices.



If you would consider this proposition, we would be pleased to go into the matter further with you.

Yours truly,

DOMINION CONSTRUCTION CO. LIMITED

(signed) R. C. Huffman."

The Dominion Dredging Co. Limited, replied on January 1st, 1917, as follows:-

(Copy)

"The Dominion Dredging Co., Limited

Ottawa, Canada,
January 1, 1917.

Sir Adam Beck, K.B.,
Chairman, Hydro-Electric Power Commission,
Toronto.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross. (G-29)

Dear Sir:-

On November 28th last we wrote a letter to the Secretary of the Commission in regard to the proposed Chippawa Power Canal. We received a reply from your Chief Engineer, dated Dec. 26th, advising us that you were not in a position to ask for a proposition on Dredging. When writing our letter we had not in mind any dredging proposition, as this has been only a part of our work on the Welland Ship Canal, and outside of our Dredging plant we have a large land excavation plant consisting of steam shovels, drag lines, locomotives, etc. This plant with the plant on No. 2 Section owned by Baldry, Yerburgh & Hutchinson, we are under the impression would be sufficient to undertake the work on the Chippawa Power Canal. We discussed the matter with Mr. Hutchinson, of Baldry, Yerburgh & Hutchinson, and as a result wrote your Secretary as fully as possible and understand that Baldry, Yerburgh & Hutchinson did the same.

In a memorandum enclosed in your letter to us of Dec. 26th, we note that you have asked a few firms for prices on the excavation work to be in on January 2, 1917. Mr. Hutchinson informs us that he did not receive notice to this effect and was preparing a proposition along the lines discussed with you personally some time ago, and intends submitting the same during this week.



In order to get some information in regard to proposals to be submitted on Jan. 2, 1917, we called upon your Mr. Acres and the Secretary of the Commission on Saturday last and were informed by Mr. Acres that the prices asked for were in no way binding and were only for the information of your engineers as to what prices they might expect to receive if public tenders were invited. We were assured that no action as to awarding a contract would be taken on the prices submitted on Jan. 2, 1917, and under these circumstances we would not feel justified in submitting a price as your Mr. Acres informed us that they would expect us to stand by this price or a better one if the Commission decided to invite public tenders for the work.

We have been acting in this matter with Baldry, Yerburgh & Hutchinson, and our action in not submitting a price on Jan. 2nd in no way interferes with the proposition he is submitting for us jointly to you this week in regard to the work.

Yours truly,

THE DOMINION DREDGING CO. LIMITED.

(signed) E. A. Larmonth, Secy.-Treas."

Under date of Jan. 2nd, 1917, Messrs. William Cowlin & Son (Canada) Limited, replied as follows:-

(Copy)

"William Cowlin & Son

The Mail Building, 106 Bay Street.
Toronto, Jan. 2, 1917.

Hydro Electric Power Commission of Ontario,
University Ave.,
Toronto.

Dear Sirs:-

COPY

Niagara Power Development

We have very carefully investigated the Specifications and Plans of this proposed Development. We have been unwillingly driven to the conclusion that it is not possible for us to submit a firm Tender for the rock and earth excavation in this work. The main factor in our arriving at this decision being, the extreme uncertainty as to the labor conditions and the refusal of merchants to cover us in plant and materials for any definite period.

We would ask to be permitted to place before the Commission the following offer:

To supply Permanent Construction Plant sufficient to undertake all the rock and earth excavation from Montrose to Smeaton's Curve comprising Shovels, Channelling Machines, Pumps, Drills etc. Steam Locomotives and Locomotive Cranes; also the rails for the loading sidings and at the dump; also connections and pipe lines. Our offer would not include the providing or laying of the main through route, nor equipment including locomotives for the operation of the through route, nor does this include the plant for handling other materials than the rock and earth excavation.

We would undertake to carry out the work all as described in the contract and to have this completed within 3 years of the Main Line Railway to be installed by you being in working order.

As remuneration we would require twenty-two and one-half per

COPY

cent (22½%) on the total cost of the work up to a value of five million dollars ($5,000,000.00). On any amount in excess of this sum we would accept ten per cent (10%) as remuneration. For this remuneration we would provide all the plant required for the earth and rock excavation as described and our services in the general organization and handling of the work. All pay sheets for the staff on the works; all accounts for materials, and all charges for the operation of the Construction Plant to be met by the Commission.

We have had large experience in this class of work, and also in the operation of Steam and Electric Railways.

We would be willing to undertake the operation of the Commission's Main Line Railway if desired.

Yours faithfully,

WILLIAM COWLIN & SON (CANADA) Limited,



(signed) M. Kendall,
Managing Director."

The engineers of the Hydro-Electric Power Commission say that, having in view the problems of design yet unsolved and also the absolute necessity of unfettered facilities for instituting and maintaining a maximum degree of progress, in the face of onerous priorities being exercised by the various Governments involved in the war, it was considered by the Hydro-Electric Power Commission that no proposition short of fixed contract prices had any merit as compared with the force account method of procedure.

Under the circumstances, there was evidently need for a maximum of flexibility in adapting construction methods to the solution of many special and unique problems which could be viewed in full perspective and detailed on paper only as the work progressed. Moreover, the war at this time was in a very serious stage for the Allies, and there was no assurance that it might not be protracted for many years.

The Hydro-Electric Power Commission consequently decided to proceed with the Canal work by force account.

In prosecuting the work by force account the engineers of the Hydro-Electric Power Commission purchased the plant employed with one important exception, namely that of the rental of the Dredge "Cyclone", with its equipment, from the Toronto Harbour Commissioners.

## Screen House, Power House and Tail-race

When the decision to proceed with construction was made in the Spring of 1917, the capacity of the main units in the Power House, and the general overall dimensions of the Screen House and the Power House, constituted practically the only important elements of the design which had been definitely fixed. The arrangement and the design of the penstock inlets, the ice sluice-way and the Power House substructure still remained to be decided and, although understood, they had not been co-ordinated into a sufficiently definite final design to permit the preparation of the detail plans. The elimination of hydraulic losses in the Screen House waterways, the design of great penstocks under a high head, and the general characteristics and details in connection with the largest Johnson valves ever designed, and of turbines much greater than any others hitherto constructed, constituted problems which demanded study and revision up to the extreme limit of time permissable under the schedule for completion in 1921 fixed by the Hydro-Electric Power Commission. This condition necessarily retarded progress in the preparation of the final plans for the buildings, and, if

the excavation work for the Screen House and the Power House had not been commenced on the basis of fixed overall dimensions, it would have been impracticable to complete the first two units of the installation by the end of the year 1921. The work in the Screen House, the Power House and the Tail-race was done with plant purchased for the Canal, being released as occasion arose and transferred to the most advantageous position.

It was necessary to hold the details of the Power House substructure design somewhat in abeyance until the tenders and specifications of the turbine manufacturers had been received, and until the turbine contracts were awarded. When the contract for the turbines of Units 3, 4 and 5 was let to the William Cramp & Sons, Ship and Engine Building Co., I. P. Morris Department, the engineers of the Hydro-Electric Power Commission effected a material gain in part gate turbine efficiency by a change in the substructure design which involved four out of the five turbine units then on order, turbine Units 1 and 2 having been let to the Wellman-Seaver-Morgan Co. The engineers of the Commission considered that this change in design was of such a radical nature that its consummation would have necessitated the abrogation of a schedule contract had the work been progressing under that method of procedure.



The design of the Power House substructure was similarly affected by the development of the details and the general design of the main generators, and to an even more marked degree by the protracted study which the manufacturers gave to the switching problem, involving, as it did, the safe handling and manipulation of unprecedentedly large quantities of electric energy at high voltage and under short circuit conditions not previously contemplated.

Generally, it may be said that the conditions surrounding the design and construction of the Screen House and the Power House were such as to make the problem one which was susceptible of safe solution only by consecutive steps, following various final decisions arrived at in conference with manufacturing specialists who had to do with the vital elements of hydraulic and electrical machinery installation.

Considering these circumstances in conjunction with the intensive working schedule, it is doubtful whether this portion of the work could have been let by contract even under normal pre-war conditions.



Contracts.

In accordance with standard practice, the Hydro-Electric Power Commission placed contracts with specialists for the manufacture and erection of the more important elements of the development such as structural steel work, turbines, generators, cranes, and so forth. With the exception of the bridge superstructures which are dealt with in a separate Chapter, the following are the principal engineering contracts entered into:-

Dominion Bridge Company, Limited, Montreal, Quebec.

March 29, 1921 - Superstructure for Control Gate, erected .. $ 6,000.00

Canadian Bridge Company, Walkerville, Ontario.

May 16, 1920 - All structural steel for Queenston Generating Station, erected, per ton of 2000 pounds .... $ 135.00

Turnbull Elevator Company, Toronto, Ontario.

May 26, 1921 - Three electric Elevators, installed ..... $ 36,700.00
(Sales Tax Extra)

McGregor & McIntyre, Limited, Toronto, Ontario.

February 26, 1921 - Structural steel for Screen House,
erected ..... $ 39,606.00
(Sales Tax Extra)

Larner-Johnson Valve & Engineering Co. Philadelphia, Pennsylvania.

January 11, 1921 - Two Johnson Valves, 42" inlet, erected .. $ 25,800.00

Larner-Johnson Valve & Engineering Co. Philadelphia, Pennsylvania.



May 13, 1920 - Five Johnson Valves, 14 ft., erected ..... $239,710.00

Wellman-Seaver-Morgan Co., Cleveland, Ohio.

October 7, 1921 - Spare parts for Turbine, delivered ..... $ 4,400.00

Wellman-Seaver-Morgan Co., Cleveland, Ohio.

June 30, 1919 - Two Turbines, 52,500 horse power each,
installed ..... $243,846.00
(more or less)
Price to be adjusted according to variation
in price of metals.

William Cramp & Sons, Ship and Engine Building Co. Philadelphia, Pennsylvania.

July 8, 1920 - Three Turbines, 55,000 horse power each,
installed ..... Not to exceed ..... $765,000.00
Price varies with duty, freight and exchange.

Canadian Allis-Chalmers, Limited, Toronto, Ontario.

February 4, 1921 - Two Service Turbines with Governors,
installed ..... $ 65,000.00

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross. (G-36)

Canadian Westinghouse Company, Hamilton, Ontario.

December 3, 1920 - Two 2,200 k.v.a. Service Generators, installed ..... $ 90,290.00

The Canadian General Electric Company, Toronto, Ontario.

February 26, 1920 - Two 45,000 k.v.a. Generators, installed ..... $1,000,000.00

Canadian Westinghouse Company, Hamilton, Ontario.

February 11, 1919 - Two 45,000 k.v.a. Generators, installed ..... $ 913,550.00

February 26, 1920 - One 45,000 k.v.a. Generator, installed $ 455,500.00



Dominion Bridge Company, Limited, Montreal, Quebec.

March 31, 1920 - Two 150-ton Electric Cranes, installed .. $ 93,160.00

Dominion Bridge Company, Limited, Montreal, Quebec.

November 1, 1920 - Five steel Penstocks, erected ..... $ 620,122.00

All these contracts were proceeded with in due course and at the moment of writing have all been substantially completed with the exception of the generator for Unit No. 5 under contract with the Canadian General Electric Company.

Walter J. Francis

Toronto, November 30th, 1922. (Consulting Engineer.